RESPONSES TO U.S. ENVIRONMENTAL PROTECTION AGENCY COMMENTS ON THE SUPPLEMENT TO THE DRAFT EIS (Comment Document 10231)

1. The Final EIS includes this Comment-Response Document, which identifies and addresses each of the comments received on both the Draft EIS and the Supplement to the Draft EIS. In response to public comments, DOE modified the Final EIS in a variety of ways, including clarifications or changes to the text, updating information, and modifying analyses. The Department considered comments on the Draft EIS in preparation of the Supplement to the Draft EIS (which were appropriately carried forward to the Final EIS). In part, for example, the comments received on the Draft EIS influenced DOE's description of the Science and Engineering Report design elements presented in the Supplement. The Supplement was limited in scope to "aspects of the design that have changed since DOE issued the Draft EIS" (which did not include transportation).

   Consistent with Council and Environmental Quality and DOE regulations, the Department did not release the Comment-Response Document before issuing this Final EIS or hold hearings on the Comment-Response Document or this Final EIS.

2. In response to public comments, DOE modified the Final EIS in a variety of ways, including incorporation of the flexible design (introduced in the Yucca Mountain Science and Engineering Report and the Supplement to the Draft EIS), clarifications or changes to the text, updating information, and modifying analyses. DOE believes that the environmental impacts presented in the Final EIS for the flexible design (and its associated operating modes) bound reasonably foreseeable actions.

   In June 2001, DOE conducted three public hearings on the Supplement to the Draft EIS to provide the public with opportunities to comment on the Project's latest plans for design and operation. In September and October 2001, the Project conducted hearings on key documents that were released in advance of a potential Site Recommendation [*theYucca Mountain Science and Engineering Report* (DIRS 153849-DOE 2001) and the *Preliminary Site Suitability Evaluation* (DIRS 155734-DOE 2001)].

   Upon issuance of the Final EIS, the public will have the opportunity to examine the Comment-Response Document and the Department's response to the public's comments. This approach is consistent with regulations issued by the Council on Environmental Quality and DOE's implementation procedures at 10 CFR 1021.

   Should the Secretary of Energy recommend Yucca Mountain to the President, however, the recommendation would be accompanied by several supporting documents including the Final EIS and its Comment-Response Document. In the event Yucca Mountain was authorized and the project moved forward, DOE would submit a License Application to the Nuclear Regulatory Commission. The Nuclear Regulatory Commission's licensing process would afford the public additional opportunities to review and comment on the specific design elements of the Yucca Mountain repository. In the event that DOE incorporated additional design modifications subsequent to the submittal of a License Application, the Nuclear Regulatory Commission's licensing process would provide additional opportunities for the public to comment on the repository.

3. After DOE issued the Supplement to the Draft EIS in May 2001, both the Environmental Protection Agency standards at 40 CFR Part 197 and the Nuclear Regulatory Commission licensing criteria at 10 CFR Part 63 were promulgated. In addition, in 2001 DOE promulgated its 10 CFR Part 963 guidelines to be consistent with the adopted EPA standards and the NRC licensing criteria. The estimated impacts presented in the Final EIS fully consider, and provide comparisons with, the final standards as promulgated. DOE has modified Chapter 11 of the EIS to include the final regulations.

4. A postclosure monitoring program is required by 10 CFR Part 63. This program would include the monitoring activities that would be conducted around the repository after the facility was closed and sealed. The regulations require that a license amendment be submitted for permanent closure of the repository [10 CFR 63.51(a)(1) and (2)]. This amendment must specifically provide an update of the assessment for the

repository's performance for the period after permanent closure, as well as a description of the program for postclosure monitoring. This program would include continued oversight to prevent any activity at the site that posed an unreasonable risk of breaching the geologic repository's engineered barriers; or increasing the exposure of individual members of the public to radiation beyond allowable limits. The details of this program would be defined during the processing of the license amendment application for permanent closure. Deferring a description of this program until the closure period would allow for the identification of appropriate technology including technology that could become available in the future.

5. The description in the Supplement to the Draft EIS should have read: Other support facilities planned for the North Portal Operations Area include basic facilities for personnel support, warehousing, security, and transportation (motor pool). Section 2.1.2.1.1 of the Final EIS reflects this clarification.

6. To avoid compromise, details of physical security plans are typically not made available to the public. However, DOE believes that security for the spent nuclear fuel surface aging facility would be similar to that required for existing commercial Independent Spent Nuclear Storage Facilities currently licensed by the Nuclear Regulatory Commission. At a minimum, security controls would include positive control on ingress and egress at the facility, as well as periodic surveillance by security personnel. Detailed security requirements for all areas of the proposed repository, including the fuel aging facility, would be included in the construction and operating license approved and issued by the Nuclear Regulatory Commission.

7. The flexible design does include monitoring of the exhaust air and the ability to filter the exhaust stream if radioactive contamination was detected. The design would comply with applicable health and safety requirements.

8. The Final EIS is based on the flexible design described in detail in the Science and Engineering Report (DIRS 153849-DOE 2001). Thermal management of the proposed repository would involve complex, nonlinear relationships among many parameters of the repository system [see the Science and Engineering Report (DIRS 153849-DOE 2001) for further discussion]. The major determinants of the peak temperatures are the age of the fuel at emplacement, the linear heat load along each drift, and the ventilation period after emplacement. By keeping the drift spacing constant, the overall feasibility of the various repository operating modes can be evaluated. The analysis presented in the Science and Engineering Report supports the environmental impact conclusions in the EIS. The Science and Engineering Report recognizes that the thermal load or areal mass loading can be varied also by the liner thermal load (which was done in the Science and Engineering Report), the drift spacing (which was not done in the Science and Engineering Report), or both. By varying the fuel age, waste package spacing, and ventilation, DOE has considered the major factors that would affect temperature variations in the repository. As noted in both the Science and Engineering Report and the Supplement to the Draft EIS, future studies could include variations in drift spacing. At present, DOE does not expect the conclusions drawn from the analysis in the Final EIS to change substantially as a result of variations in drift spacing versus waste package spacing.

9. As mentioned in Section 2.4 of the Supplement to the Draft EIS, uncertainties in future funding or the order of waste shipments might require the repository to be developed in a sequential manner, such as constructing the surface and subsurface facilities in portions or "modules." This approach would incorporate "lessons learned" from initial work into subsequent modules, reduce the initial construction costs and investment risk, and potentially increase confidence in meeting the schedule for waste receipt and emplacement. The intent of this discussion was not to imply that uncertain funding would increase confidence.

10. The information and analyses used to estimate the reasonably maximally exposed individual doses are provided in Appendix H. National Emission Standards for Hazardous Air Pollutants (40 CFR Part 61) are applicable only to routine or permitted releases. They do not apply to accidents. Since publication of the Draft EIS, the Environmental Protection Agency promulgated *Public Health and Environmental Radiation Protection Standards for Yucca Mountain, Nevada,* at 40 CFR Part 197, which included an annual dose limit to a member of the public of 15 millirem (40 CFR 197.4). In accordance with requirements of the Energy Policy Act, the Nuclear Regulatory Commission subsequently promulgated Yucca Mountain licensing criteria, which includes a Preclosure Public Health and Environmental Standard at 10 CFR 63.204 of 15 millirem per year to a member

of the public. The appropriate sections of the EIS (including those mentioned in Chapter 8) have been updated to reflect a comparison to the recently promulgated standard of 15 millirem.

11. The flexible design presented in the Supplement to the Draft EIS was carried forward to the Final EIS analyses.

12. Golder Associates, Inc., developed both GoldSim (the integrating software used for the Supplement to the Draft EIS and Final EIS) and RIP (the software used for the Draft EIS). GoldSim is a new generation of the RIP program, not an entirely different program. The differences have more to do with user interface convenience and the mechanics of data handling than with the actual modeling. Nevertheless, as part of the production, delivery, and documentation of GoldSim, Golder Associates validated that program against RIP by running similar cases in both. Thus, differences in the integrating software caused no differences between the Draft EIS, the Supplement to the Draft EIS, and the Final EIS.

13. The modeling for the Supplement and the Final EIS for long-term performance analysis includes improved coupling of these processes over the essentially uncoupled versions used for the Draft EIS. Section I.2.3 of the Final EIS and the documents referenced in that chapter discuss these models.

14. As reported in *Nuclear Waste Fund Fee Adequacy: An Assessment* (DIRS 153257-DOE 2001), the nuclear waste fund investments had a market value of $8.5 billion as of September 30, 1999. The analysis in the report found that the current fee of 1 mil (one tenth of 1 cent) per kilowatt hour charged to generators of commercial spent nuclear fuel was adequate to cover projected disposal expenses (including costs associated with packaging and transportation) and recommended that the fee remain unchanged.

    Section 302 of the Nuclear Waste Policy Act of 1982 specifies that funding for disposal of commercial spent nuclear fuel is provided by payment of fees to the Secretary of Energy by the generators of electricity from nuclear power plants. Equivalent amounts are paid by the Federal Government to cover similar costs associated with disposal of spent nuclear fuel or high-level radioactive waste generated or owned by the United States. Utility fees and Federal appropriations are required to be sufficient to offset expenditures associated with repository studies; transportation; and operations and closure of a repository, as determined by an annual review by the Secretary of Energy. In the event that future generations decide that the potential repository should remain open for an extended period (up to 300 years or more), the fee structure could require modification. The statement, about "uncertain funding," was intended to be in the context of funding requirements for those activities (in the relative near-term leading up to the ability to receive and emplace waste (if the site was recommended and approved), and was not intended to reflect doubt about funding once the facility, if approved, became operational.

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

RECEIVED
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February 22, 2000

Dr. Ivan Itkin, Director
Office of Civilian Radioactive Waste Management
U.S. Department of Energy, Headquarters
1000 Independence Avenue, S.W.
Washington, DC 20585

SUBJECT: U.S. NUCLEAR REGULATORY COMMISSION COMMENTS ON THE U.S. DEPARTMENT OF ENERGY DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR A GEOLOGIC REPOSITORY FOR THE DISPOSAL OF SPENT NUCLEAR FUEL AND HIGH-LEVEL RADIOACTIVE WASTE AT YUCCA MOUNTAIN, NYE COUNTY, NEVADA

Dear Dr. Itkin:

On August 13, 1999, the U.S. Department of Energy (DOE) published a notice of availability in the Federal Register of its draft environmental impact statement (DEIS) for a geologic repository for the disposal of spent nuclear fuel and high-level radioactive waste at Yucca Mountain, Nye County, Nevada. In the context of the Nuclear Waste Policy Act, as amended, DOE is the lead agency for considering the environmental impacts for the proposed repository, and the U.S. Nuclear Regulatory Commission (NRC) is to adopt the DOE Final Environmental Impact Statement (FEIS) to the extent practicable as part of NRC's licensing actions for the repository. Consistent with its responsibilities, the NRC has promulgated, in 10 CFR Part 51, criteria it will use to adopt the FEIS. With respect to the DEIS, the NRC is a commenting agency. The NRC comments are enclosed.

In reviewing the DEIS, the NRC based its comments on its judgment regarding environmental issues, guided by: 1) the Council on Environmental Quality (CEQ) regulations (40 CFR Part 1500) implementing the National Environmental Policy Act; 2) guidance prepared by CEQ and the U.S. Environmental Protection Agency; and 3) NRC's criteria in 10 CFR Part 51 for adopting the FEIS.

The enclosed staff comments are organized into three categories. The first category is comprised of four comments that the NRC believes should be addressed by DOE to make the FEIS complete. These four comments concern broad issues in the DEIS, specifically: integration of the Proposed Action, cumulative impacts, transportation, and mitigative measures. When DOE submits an application for a license for the repository, the FEIS should contain sufficient information to allow a reasonable evaluation of the environmental impacts of that Proposed Action.

The remaining comments apply to more specific topical areas within the DEIS. The second category of comments (comments 5 through 8) also addresses issues related to completeness, albeit less directly than those in the first category. Those four comments have less significance than the first four comments, but DOE should address all eight comments to make the FEIS

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1 complete. The final five comments (9 through 13) are offered for DOE's consideration. In preparing the FEIS, NRC also requests that DOE consider relevant technical comments previously submitted by the NRC. The NRC has provided such technical comments in reports on specific technical issues and in comments on DOE's Viability Assessment in June 1999.

The comments on the Viability Assessment also address the issue of quality assurance (QA). DOE's application of a rigorous and effective QA program is crucial to its ability to demonstrate the validity of its findings and analyses in any license application. The NRC staff will continue to evaluate DOE's efforts to implement an effective QA program.

We are available to meet with your staff to discuss our comments and recommendations. Please contact Charlotte Abrams, Team Leader, Environmental Review Team, if you have any questions regarding this letter or the enclosure. Ms. Abrams can be reached at (301) 415-7293.

Sincerely,

William F. Kane, Director
Office of Nuclear Material Safety
and Safeguards

Enclosure: U.S. NRC's Comments on U.S. DOE's
Draft Environmental Impact Statement for
a Geologic Repository for the Disposal of
Spent Nuclear Fuel and High-Level Radioactive
Waste at Yucca Mountain, Nye County, Nevada

cc w/encl: See attached list

Wendy R. Dixon, EIS Project Manager
Yucca Mountain Site Characterization Office
Office of Civilian Radioactive Waste Management
U.S. Department of Energy
P.O. Box 30307, Mail Stop 010
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Letter to Ivan Itkin, U.S. DOE dated: 2/22/2000

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J. Wallis, Mineral County, NV
L. Bradshaw, Nye County, NV
M. Murphy, Nye County, NV
J. McKnight, Nye County, NV
N. Stellavato, Nye County, NV
D. Kolkman, White Pine County, NV
D. Weigel, GAO
W. Barnard, NWTRB
R. Holden, NCAI
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R. Arnold, Pahrump County, NV
J. Lyznicky, AMA
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**U.S. Nuclear Regulatory Commission's Comments on
U.S. Department of Energy's Draft Environmental Impact Statement
for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level
Radioactive Waste at Yucca Mountain, Nye County, Nevada**

This enclosure provides comments by the U.S. Nuclear Regulatory Commission (NRC) staff on the draft environmental impact statement (DEIS) prepared by the U.S. Department of Energy (DOE) for a geologic repository for the disposal of spent nuclear fuel (SNF) and high-level radioactive waste (HLW) at Yucca Mountain, Nye County, Nevada. The DEIS addresses a wide range of possible impacts of this complex project. A significant amount of information, including multiple options for key components of the Proposed Action, is presented in the DEIS.

2 The NRC believes it to be desirable that DOE more clearly define a Proposed Action comprised of a preferred option for each component or a bounding analysis that gives a better understanding of the potential impact of each component. The NRC recognizes the utility of DOE's preserving, to the extent possible, repository design flexibility. Nevertheless, in the interest of improving the focus of its National Environmental Policy Act (NEPA) analysis, the NRC requests DOE to prepare, in the final environmental impact statement (FEIS), an in-depth analysis of a clearly defined Proposed Action, or, at the least, to provide sufficient information and analysis of the various options that it has retained as to demonstrate that the environmental impacts of the repository are bounded. A number of the attached NRC comments relate to the value in defining an integrated Proposed Action.

3 The assessment of long-term radiological impacts is based on the results of site characterization and the development of models describing repository performance. NRC and DOE have had extensive pre-licensing consultations concerning site characterization and NRC staff has provided comments on these matters. Staff's comments in these areas were provided to DOE in reports on specific technical issues (e.g., Issue Resolution Status Reports for Key Technical Issues) and in comments on DOE's viability assessment (VA). These technical comments should be considered during the development of the FEIS.

The enclosed staff comments are organized into three categories. The first category is comprised of four comments that the NRC believes should be addressed by DOE to make the FEIS complete. These four comments concern broad issues in the DEIS, specifically: integration of the Proposed Action, cumulative impacts, transportation, and mitigative measures. When DOE submits an application for a license for the repository, the FEIS should contain sufficient information to allow a reasonable evaluation of the environmental impacts of that Proposed Action.

The remaining comments apply to more specific topical areas within the DEIS. The second category of comments (comments 5 through 8) also addresses issues related to completeness, albeit less directly than those in the first category. Those four comments have less significance than the first four comments, but DOE should address all eight comments to make the FEIS complete. The final five comments (9 through 13) are offered for DOE's consideration. In preparing the FEIS, NRC also requests that DOE consider relevant technical comments previously submitted by the NRC. The NRC has provided such technical comments in reports on specific technical issues and in comments on DOE's Viability Assessment in June 1999.

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COMMENTS

Category 1 -- Comments That Should be Addressed to Ensure the Completeness of the FEIS

INTEGRATION

1. **Comment:**

4... The DEIS discusses five components relating to: 1) construction of the repository and waste handling facilities; 2) preparation of SNF and HLW at 77 sites for transport; 3) transportation of the SNF and HLW to Yucca Mountain by use of a National transportation network and a transportation network in the State of Nevada; 4) repository operations, including packaging, waste emplacement, monitoring and closure; and 5) mitigation and monitoring. The NRC recognizes the utility in DOE preserving, to the maximum extent practicable, design flexibility and therefore understands why DOE has presented a number of options for public consideration for each of these components. However, the DEIS does not identify a preferred option for each component. Further, it does not provide an integrated description of a clearly defined Proposed Action (comprised of the various components) and of the direct, indirect, and cumulative environmental effects of the integrated action. As a result, it is not clear that DOE has bounded the environmental impacts that could arise from the repository. As it prepares the FEIS, we request that DOE prepare an in-depth analysis of a clearly defined Proposed Action, or, at the least, to provide sufficient information and analysis of the various options that it has retained as to demonstrate that the environmental impacts of the repository are bounded.

Basis:

The DEIS describes numerous options for the various components of the repository system. For example, in Appendix F, two potential configurations of waste packaging for shipment were analyzed: uncanistered and canistered. In Chapter 6, two "National-level" transportation scenarios were analyzed (mostly truck and mostly rail) and eleven Nevada transportation alternatives were considered. Additionally, three potential thermal load scenarios and three waste volume options for the repository were considered in Chapters 4 and 5.

Given the number of components and options within those components, the repository system could consist of one of the numerous possible permutations. The DEIS does not select among the various options to identify a single, integrated Proposed Action. Moreover, the DEIS does not present an integrated overall description and impact assessment of any complete combination for the Proposed Action, and it is not clear that the analyses of the various components presented in the DEIS bound the impacts that could result from the Proposed Action, once one is selected. Instead, descriptions and impacts are treated separately, discussed separately, with conclusions drawn separately. Although NRC recognizes the importance of DOE's retaining flexibility to make changes in its design, and of obtaining public input in the selection among the available options, the FEIS should contain sufficient information and analysis of the

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4 cont. various options to cover the Proposed Action that is ultimately selected and to allow a reasonable assessment of the impacts of that Proposed Action.

Concerns identified in this comment are linked to comments on cumulative impacts (see Comment 2), transportation in Nevada (see Comment 3), and mitigation (see Comment 4).

Recommendation:

In the interest of improving its analyses, the NRC recommends that, to the extent choices among options have been refined, DOE identify its Proposed Action in the FEIS. Further, the NRC suggests that DOE use its refined description of the Proposed Action to complete the assessment of the direct, indirect, and cumulative effects of the Proposed Action, making bounding assumptions when necessary or appropriate. At the least, if DOE chooses to retain flexibility in the FEIS, it should show that the indirect, direct and cumulative impacts of the eventual selection have been bounded by the assessments presented in the FEIS.

CUMULATIVE IMPACTS

2. **Comment:**

5... The assessment of cumulative impacts in the DEIS does not fully address the impacts associated with past, present, and reasonably foreseeable future actions relating to groundwater use, land use, and cultural and biological resources.

Basis:

A "cumulative impact" is an impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions (40 CFR 1508.7). A complete cumulative impacts assessment would provide an understanding of whether the Proposed Action (see Comment 1) might push a resource, ecosystem, or human community beyond a critical threshold and preclude sustainability (CEQ, 1997, page 7). Therefore, the FEIS should assess the additional, incremental impacts from the action at hand when added to impacts from past, present, and reasonably foreseeable future actions (40 CFR 1508.7).

Section 4.1.3 (Environmental Consequences of Repository Construction, Operation and Monitoring, and Closure — Impact to Hydrology) acknowledges that repository construction and operation will impose water demands on the available supplies at Yucca Mountain and the surrounding area. Similarly, Section 6.3.2.1 (Impacts Common to Nevada Branch Rail Line Implementing Alternatives) acknowledges that water withdrawal will be required to support construction of a branch rail line. These demands could create impacts on water resources, particularly in light of other possible future uses. Creation of a Timbisha Shoshone Tribal Homeland with agricultural water rights is a reasonably foreseeable action that could contribute to exceeding the sustainable yield in the Death Valley National Park region (Buqo, 1999, p. 25). Further, it is foreseeable

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5 cont. that the continued growth of Clark, Nye, and Lincoln Counties and Las Vegas, Pahrump, and Beatty will impact available groundwater resources. An increased cumulative demand for water, particularly when coupled with reduced water supplies resulting from land withdrawal and Federal land acquisition, could lead to aquifer overdrafting, increased pumping costs, and associated socioeconomic impacts. The cumulative impacts on groundwater resources stemming from the Proposed Action and these other actions are not adequately considered in the DEIS.

The cumulative impacts assessment also needs to further evaluate combined impacts to other specific resources (e.g., the desert tortoise, land use, cultural resources). The cumulative impacts of a Proposed Action, coupled with other Federal actions in the area (e.g., activities at NTS, Nellis Air Force Range (AFR)) and impacts from extensive growth in Nye, Lincoln, and Clark Counties, on the ranges and habitats of local fauna, such as the desert tortoise, should be documented. In addition, land withdrawal by DOE in conjunction with Department of Interior limitations on land use in Ash Meadows may result in cumulative impacts related to land use that have not yet been fully assessed. Similarly, the impact that private projects such as the Cortez Gold Mine Pipeline projects and the Apex Bulk Commodities Intermodal Transfer Station have on resources (e.g., biological and cultural resources) may not have been fully considered.

Recommendation:

DOE should complete its analysis of cumulative impacts for resources, ecosystems, and human communities by augmenting analyses already performed for individual components for the proposal. The analysis should consider all past, present, and reasonably foreseeable future actions, both Federal and non-Federal, within appropriate spatial and temporal boundaries.

References:

Buqo, T.S. *Nye County Perspective: Potential Impacts Associated with Long Term Presence of a Nuclear Depository at Yucca Mountain, Nye County, Nevada.* June 1999.

Council on Environmental Quality, *Considering Cumulative Effects Under the National Environmental Policy Act*, CEQ, January 1997.

TRANSPORTATION

3. **Comment:**

6... In the absence of a preferred route and mode of transportation, it is unclear whether the non-radiological impacts related to transportation of SNF and HLW within Nevada, including impacts from construction and operation of intermodal transfer stations and rail lines, have been bounded.

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6 cont. **Basis:**

The DEIS identifies the transportation of SNF and HLW as one of the components necessary for a repository. As such, transportation is a connected action (40 CFR 1508.25(a)(1)) and should be considered an integral part of the Yucca Mountain project. The NRC understands that DOE would like to benefit from public input, through comments on the DEIS, when considering preferred transportation modes and routes. However, an integrated impact assessment that connects transportation to disposal needs to be included as part of any evaluation of the Proposed Action in the FEIS.

The current analysis for transportation within the State of Nevada provides a general discussion of impacts, but does not fully assess the non-radiological impacts. Further, it is not apparent that the transportation analysis in the DEIS bounds the non-radiological impacts (e.g., socioeconomic impacts and impacts to air quality, cultural and biological resources, and land and water use). Moreover, although DOE has identified a number of options, it has not clearly defined which options (e.g., rail line construction, mode of transportation, need for intermodal transfer stations, preferred routing within the State of Nevada, and type of trucks) it will use to support the Proposed Action.

As noted in Comment 1, the FEIS should show that, once decisions on transportation routes and modes are made, no new information or circumstances exist that could result in significant changes to the impacts assessed in the FEIS.

Recommendation:

Transportation impacts (including non-radiological and cumulative impacts) should be discussed in sufficient detail to support selection of a Proposed Action. The FEIS should contain either a complete, integrated assessment of the connected transportation actions or sufficient information and analyses on the various options to show that the impacts of the Proposed Action have been bounded.

MITIGATION OF ACTIONS

4. **Comment:**

7... The DEIS does not include a thorough discussion of mitigative measures or of long-term environmental monitoring to measure the impacts on the environment.

Basis:

As noted in Comment 1, the DEIS does not identify what options will be combined for a Proposed Action. Public comments on the DEIS can be used by DOE to help in the selection of those options that will form the Proposed Action, refine its analysis of environmental impacts, and evaluate the need for particular mitigative measures. In this connection, it is important to ensure that all environmental impacts have been identified or bounded in order to provide a basis for decisions for mitigative measures. Mitigative strategies currently address dust suppression, the desert tortoise, and occupational health and safety. In addition, the FEIS needs to evaluate the need for mitigative

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7 cont. strategies for water use, economic, social, cultural, biological, or public health and safety impacts.

For example, the discussion in Chapter 9 (Management Actions to Mitigate the Potential for Environmental Impacts) of the DEIS does not fully address mitigative measures for Native American interests, including several measures presented by the AIRD (American Indian Writers Subgroup, 1998), such as ways to alleviate the severity of the effects on Native American cultural, religious, subsistence, recreational, ceremonial and associated uses of Yucca Mountain. The suggested mitigation actions in the AIRD include providing emergency preparedness training, establishing emergency medical facilities, and providing controlled access to sacred or ceremonial areas or resources.

Further, it is not apparent that a complete monitoring program for mitigative strategies has been clearly defined. The FEIS should include monitoring as a way of evaluating the effectiveness of any mitigative measures, such as measures to reduce impacts from transportation or waste handling at intermodal or site surface-based facilities (40 CFR 1505.2(c)).

Recommendation:

The FEIS should provide reasonable mitigative strategies to address potentially significant adverse impacts from the Proposed Action. Mitigative measures which comprise these strategies should be implementable and effective in reducing environmental impacts. Moreover, the FEIS should discuss monitoring to assess the environmental impacts and the effectiveness of planned mitigative measures. As appropriate, this monitoring could be integrated with DOE's long-term performance confirmation monitoring.

References

American Indian Writers Subgroup. *American Indian Perspectives on the Yucca Mountain Site Characterization Project and the Repository Environmental Impact Statement.* American Indian Resource Document MOL 19980420.0041. Las Vegas, NV: American Indian Writers Subgroup, Consolidated Group of Tribes and Organizations. 1998.

Category 2 -- Additional Comments Related to Completeness

ENVIRONMENTAL JUSTICE

5. **Comment:**

8... The DEIS discussion of the impacts on minority and low income communities is restricted to the Bureau of the Census block group data. The discussion does not provide sufficient specificity with respect to community locations within the relevant census block groups or adequately identify potentially unique community characteristics. This information would facilitate the assessment of any potential for disproportionately

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8 cont high and adverse human health and environmental effects of the Proposed Action upon these communities.

Basis:

The discussion of Environmental Justice in the DEIS does not specifically identify where minority or low-income communities are located within each census block group. This problem is compounded by the relatively large geographic size of the Nevada census block groups analyzed in the DEIS. Determining the specific locations of the potentially affected communities in each relevant census block group would facilitate evaluation of the disproportionate impacts of the Proposed Action. DOE may find that state, local, and tribal governments possess demographic information relevant to the location of these communities.

DOE's conclusion that the Proposed Action will have no significant impact on the general population, and thus no significant impact on minority and low-income communities, appears not to address the possibility that cultural, social, historical, or economic factors associated with minority and low income communities may amplify the effect of the Proposed Action and produce disproportionately high and adverse impacts upon these communities. The FEIS should discuss whether such factors exist and whether the consideration of such factors leads to the identification of significant effects that would otherwise be diluted by examination of the general population. This information could also be useful in identifying appropriate mitigative measures to address any disproportionate impacts resulting from the Proposed Action.

The NRC also notes that Section 3.1.13 (Environmental Justice) of the DEIS identifies Native Americans as having concerns about disproportionate impacts. The NRC's analysis of census data has found that there may also be African American and Hispanic minority groups in the affected area. It is not clear from the analysis in the DEIS whether these other minority groups were considered in determining if the Proposed Action has a potential disproportionate impact upon these communities.

Recommendation:

The FEIS discussion of environmental justice should identify the location and unique characteristics of minority and low income communities with sufficient specificity to enable a complete assessment of any disproportionate impacts upon those communities resulting from the Proposed Action.

WATER USE

6. **Comment:**

9... DOE should correct areas of discrepancy in water use data and provide clarifying information regarding the potential for and impacts from overdrafts of groundwater in the FEIS.

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Basis:

9 cont. Table 3-11 notes that the figures for current water appropriations do not include Federal reserved water rights (FRRs) for the NTS and Nellis AFR. These FRRs should be added to the total appropriations for a more accurate measure of committed resources.

Table 3-11 and DEIS Section 3.1.4.2.1 (Affected Environment - Regional Groundwater) suggest that ample water is available for new appropriations to support the Proposed Action because average annual withdrawals (actual use) are well below the appropriation limits. Although the use of average withdrawals may be appropriate, it is possible that this could be misleading because users are entitled to withdraw or sell their full appropriations.

When discussing the water demands expected during performance confirmation in Section 4.1.3.1 (Environmental Consequences of Repository Construction, Operation and Monitoring, and Closure - Impacts to Hydrology from Performance Confirmation) the DEIS omits mention of NTS and Nellis AFR wells in the area. The pumpage from those wells should be added to that from J-11 and J-12 and the C-well complex in the proposed land withdrawal area for an improved estimate of the water demand. The wide range in the perennial yield figures (880 to 4000 acre-feet for Area 227a) should be explained. The perennial yield and committed resources figures for Area 227a in Nevada Division of Water Planning (1992) do not agree with Table 3-11. DOE should provide additional justification for the perennial yield figures, considering the variance from information in other sources, to support its assessment of potential overdraft in the region.

The discussion of water demand during construction, operation and monitoring, and closure in Section 4.1.3.3 (Environmental Consequences of Repository Construction, Operation and Monitoring, and Closure - Impacts to Groundwater from Construction, Operation and Monitoring, and Closure) of the DEIS also should be clarified. This discussion should make clear where the water will be obtained to meet the combined water demand for the repository, the NTS, and Nellis AFR. Under one scenario, the perennial yield of Area 227a would be exceeded. The text should be clarified to explain the impacts of any possible overdraft.

The discussion in DEIS Section 4.1.3.3 (Environmental Consequences of Repository Construction, Operation and Monitoring, and Closure - Impacts to Groundwater from Construction, Operation and Monitoring, and Closure) includes at least one scenario where the Jackass Flats basin would be in overdraft status. In addition, Table 3-11 presents the Amargosa Desert Area 230 in a potential overdraft situation. DOE (1996) confirms that historic data show that DOE withdrawals at Yucca Flats have annually exceeded the perennial yield. The potential impacts of these overdrafts should be discussed.

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Recommendation:

9 cont. DOE should correct discrepancies in water-use discussions and data in the FEIS. The evaluation of groundwater use during construction, operation, and monitoring should include a discussion of the potential for overdrafts.

References:

Nevada Division of Water Planning. *Nevada Water Facts, 1992.* 241353. Carson City, NV: Nevada Division of Water Planning. 1992.

U. S. Department of Energy. *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada.* DOE/EIS-0243-F,239895. Las Vegas, NV: U. S. Department of Energy. 1996.

LAND USE

7. **Comment:**

10 Although flexibility exists in the amount of land that is to be withdrawn for the geologic repository operations area and the post-closure controlled area, the extent of the land withdrawal influences the type and magnitude of impacts that should be considered in the impact statement. The DEIS does not provide a clear basis for determining the extent of the proposed land withdrawal nor does it assess the full range of impacts associated with the land withdrawal (e.g., socioeconomic, water use, cultural).

Basis:

According to DEIS Section 1.4.1 (Purpose and Need for Agency Action—Yucca Mountain Site), the area needed for development of the surface repository is approximately 3.5 km^2 with up to approximately another 600 km^2 set aside as a buffer zone. However, the severity of impacts is dependent on the area to be withdrawn.

The FEIS should include an assessment of the potential impacts of removing a large area (e.g., 600 km^2 is used as the size of the potential land withdrawal on pages 2-1 and 2-2 of the DEIS) from other possible uses. The withdrawal would preclude or limit use of the land at any time for other purposes by the public or by Native Americans. Development of water resources on this land by private individuals, businesses, industry, or the State of Nevada might also be prohibited. These impacts are not fully assessed in the DEIS.

Recommendation:

The impacts associated with the land withdrawal should be discussed systematically in the FEIS, including impacts on cultural resources and land use.

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BIOLOGICAL RESOURCES

8. **Comment:**

11 The DEIS may not adequately bound the uncertainty in the predictions of heat generated from radioactive decay during long-term repository performance and the potential effects of this heat generation on fauna.

Basis:

Although most vertebrate species have genetically fixed sex determination, it is now known that chelonians (tortoises and turtles) undergo temperature dependent sex determination (TSD). Spotila (1994) shows that the desert tortoise (*Gopherus agassizii*), a federally listed threatened species of the Mojave Desert, is subject to this effect. Research shows that the temperature that produces a 50:50 sex ratio is 31.8 °C. Desert tortoise eggs have good hatching success between 28 and 33 °C, but suffer high mortality at temperatures below 26 or above 35.3 °C. Temperatures between 26.0 and 30.6 °C produce mostly males (temperatures 28 °C and below produce 100 percent males) and temperatures between 32.8 and 35.3 °C produce mostly females (temperatures above 33 °C produce 100 percent females) (Spotila et al., 1998). Lewis-Winokur and Winokur (1995) confirm that the pivotal temperature is between 31 and 32 °C and indicated that a lowering of 1.6 °C (from 31 to 29.4 °C) resulted in all male hatchlings.

The modeling of surface soil temperature for the proposed site produces uncertain results. TRW Environmental Safety Systems, Inc. (1999, page 44) states "...current predictions are somewhat uncertain due to uncertainties in the thermal properties of the soil, particularly thermal conductivity and, hence, thermal diffusivity." This source further states that "analyses based on conventional soil heat-conduction models indicate that the original time scale of the measurements collected at the site (weekly to monthly) could not be used to accurately estimate the soil thermal conductivity for the sampling depths chosen (15, 30 and 45 cm)." However, substantial temperature effects on desert tortoise sex determination have been shown to occur within a range of plus or minus 3 °C. Therefore, it is important for the FEIS to clarify the range of soil temperatures associated with the geologic repository and discuss impacts, if any, on protected or endangered species.

Recommendation:

The assessment of the contribution of thermal loading on increased soil temperature should be refined in the FEIS. Soil temperature modeling should take into account the substantial uncertainties in thermal conductivity in Yucca Mountain soils thereby enabling an assessment of the potential impacts to the desert tortoise from increased soil temperatures.

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References:

Lewis-Winokur,V., and R.M. Winokur. *Incubation temperature affects sexual differentiation, incubation time, and posthatching survival in desert tortoises [Gopherus agassizi (sic)]. Canadian Journal of Zoology* 73(11): 2091–2097. 1995.

Spotilla, J.R., L.C. Zimmerman, C.A. Binckley, J.S. Grumbles, D.C. Rostal, A. List, Jr., E.C. Beyer, K.M. Philips, and S.J. Kemp. *Effects of incubation conditions on sex determination, hatching success, and growth of hatchling desert tortoise, Gopherus agassizii. Herpetological Monographs* 8: 103–116. 1994.

TRW Environmental Safety Systems, Inc. *Impact of Radioactive Waste Heat on Soil Temperatures.* BA0000000–01717–5700–00030. Revision 0. Las Vegas, NV: TRW Environmental Safety Systems, Inc.: 37–44. 1999.

Category 3 -- Less significant Issues

DOCUMENTATION OF QUALITATIVE JUDGMENTS ON IMPACTS AND INCONSISTENCIES

9. **Comment:**

intro for 12, 13, 14, 15

Additional documentation or analysis should be provided in the FEIS to support the characterization of impacts and the description of environmental parameters in some areas of the FEIS.

Basis:

Additional documentation or analyses would be useful in the following areas:

12

- The DEIS assessments of impacts on faunal resources in Section 4.1.4 (Environmental Consequences of Repository Construction Operation and Monitoring and Closure—Impacts to Biological Resources and Soils) that are classified as "low," "very small," or "minimal and largely undetectable" are not supported by quantitative data. Individuals of a population that occur near the edge of its range (e.g., desert tortoises in the vicinity of Yucca Mountain) are living in marginal conditions, and therefore environmental stressors caused by the Proposed Action might have amplified effects in these edge areas.

13...

- Section 4.1.6.2.1 (Environmental Consequences of Repository Construction, Operation and Monitoring, and Closure—Impacts to Employment), page 4-41 states "[i]f the present economic growth continued in the region of influence, it could absorb declines in the repository workforce." To assess the adequacy of this statement, the assumptions used to generate the Regional Economic Models, Inc. (REMI) (Treyz et al., 1992) baseline results should be provided. The conclusion appears to require the assumption that the skills of displaced workers are compatible with the employment growth and needs of other sectors.

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14 • Section 6.3.2.2.1 (Environmental Impacts of Transportation—Caliente Rail Corridor Implementing Alternative—Socioeconomics) states "[t]he projected length of the corridor—513 kilometers—is the most important factor for determining the number of workers (560) that would be required." This statement is repeated for all corridors, but more specific information is needed to support this conclusion. Terrain and other factors might have significant impact, because productivity per worker (km/worker) varies considerably by route (e.g., 1.04 km/worker on the Carlin route, 0.53 km/worker on the Jean route).

15... • Section H.2.1.3 (Potential Repository Accident Scenarios: Analytical Methods and Results—External Events) of the DEIS concludes that 3 cm is the maximum thickness of volcanic tephra that could be deposited on repository facilities from a basaltic volcano that erupts within the area around the proposed repository site. The basis for this conclusion is a statement (DOE, 1998) that 3 cm of volcanic tephra is the worst-case event being considered. The conclusion appears not to be supported by data or analyses.

Recommendation:

The FEIS should improve the documentation and support for qualitative conclusions or assumptions related to impacts, as appropriate.

13 cont. **References:**

Treyz, G.I., D.S. Rickman, and G. Shao. The REMI economic-demographic forecasting and simulation model. *International Regional Science Review* 14(3): 221–253. 1992.

15 cont. U. S. Department of Energy. Viability assessment of a repository at Yucca Mountain. *Volume 2: Preliminary Design Concept for the Repository and Waste Package*. DOE/RW–0508. Washington, DC: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. 1998.

CULTURAL RESOURCES

10. **Comment:**

16... Documentation and analyses for the assessment of impacts to cultural resources are incomplete.

Basis:

Some DEIS conclusions regarding cultural resource impacts lack supporting analyses or reference material. Moreover, methods used to conduct the analyses and reach conclusions are not presented. The following are examples:

- Section 3.1.6.1 (Affected Environment—Archeological and Historic Resources) states that a field survey of a 44-km^2 (11,000 acres) parcel was conducted.

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16 cont. Clarifying information needs to be provided, including (i) the type of survey (e.g., walk-over); (ii) the percentage of coverage for the 44-km^2 area; (iii) the relationship of the survey area to the entire land withdrawal area; (iv) the relationship of this survey to the "additional archaeological surveys" conducted in Midway Valley, Yucca Wash, and lower Fortymile Canyon; (v) the extent and techniques used for these additional surveys; (vi) specification of the total survey area; and (vii) the extent to which sites have been identified for the complete land withdrawal area.

- Section 3.1.6.1 (Affected Environment—Archeological and Historic Resources) of the DEIS states that "826 archeological sites have been discovered in the analyzed land withdrawal area." This statement requires clarification. It is not clear whether the entire 600 km^2 parcel has been surveyed or whether the number of sites is on a smaller parcel of land. It is difficult to assess site density and cultural resources impacts without knowing the extent of the land area that has been surveyed.

- Section 3.1.6.1 (Affected Environment—Archeological and Historic Resources) states that limited test excavations were conducted at 29 sites. Clarification is required regarding the criteria used to select sites for testing and the representativeness of these sites for the potentially affected area.

- The Western Shoshone occupied the Yucca Mountain region into historic times and were engaged in mining, ranching, and other activities. The DEIS is unclear whether any of the historic sites are associated with the Western Shoshone or Paiute peoples or whether these sites are considered to be related only to non-Native American occupation activities.

Recommendation:

The FEIS should provide additional data and descriptions of methods used to assess impacts on cultural resources, including a description of the area of study used in assessing the distribution and types of cultural resources. If the entire land withdrawal area or the entire potential disturbed area was not surveyed for cultural resources, the rationale for not doing so should be presented.

LONG-TERM REPOSITORY PERFORMANCE

11. **Comment:**

17... The methodology for estimating the environmental impacts from the release and transport of toxic materials should be well documented in the FEIS. The estimates should incorporate the current waste package materials and design.

Basis:

The release and transport of toxic materials (chromium (Cr) and molybdenum (Mo)) from waste package corrosion to a receptor group was modeled using the EQ6

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17 cont. geochemical speciation code (Figure I-1). It is unclear how this code was used to estimate the corrosion products or the corrosion rate for toxic materials.

The assumed dissolution rates and mineral formation kinetics are critical to substantiating the claim that release and eventual exposure of a receptor group to the potentially toxic waste package corrosion products (e.g., chromate, molybdate) is minimal as stated in Section 5.6 (Environmental Consequences from Long-Term Repository Performance—Consequences from Chemically Toxic Materials).

We understand that DOE is expected to select Enhanced Design Alternative II (EDA-II) for the potential license application in the near term (TRW, 1999). EDA-II includes an outer overpack of 5 cm thick Alloy-22. The DEIS design includes a 2 cm thick inner overpack of Alloy-22, so the quantities of Alloy-22 will more than double, even assuming constant numbers of waste packages, if the EDA-II design is used. Because Alloy-22 is approximately 56 percent Ni by weight, the volume of Ni present in the repository is considerably more than the amount of Cr and Mo present. In addition, nickel (Ni) will also likely dissolve at roughly the same rate as Cr and Mo during corrosion. The FEIS should document that Ni does not pose a health risk.

Recommendation:

The discussion of toxic materials should be consistent with the current waste package design at the time of the FEIS. DOE should provide the technical basis for waste package corrosion rates, and should provide technical support for claims that exposure to potentially toxic materials released by waste package corrosion is minimal.

Reference

TRW Environmental Safety Systems, Inc. *License Application Design Selection Report.* B00000000-01717-4600-00123. Revision 01. Las Vegas, NV: TRW Environmental Safety Systems Inc. May 28, 1999.

REPOSITORY CONSTRUCTION, OPERATION AND MONITORING, AND CLOSURE

12. **Comment:**

18... Inconsistencies concerning the appropriate range for ^{222}Rn concentration should be remedied and impacts of thermal loading on radon release and worker safety should be explained in the FEIS.

Basis:

The median and range of ^{222}Rn concentrations used for radiological impact calculations are not consistent throughout the DEIS. Sections 3.1.8.2 (Affected Environment—Radiation Environment in the Yucca Mountain region) and F.1.1.6 (Human Health Impacts Primer and Details for Estimating Health Impacts to Workers from Yucca Mountain Repository Operations—Exposures from Naturally Occurring Radionuclides in the Subsurface Environment) of the DEIS report that radon

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18 cont. concentrations in the Exploratory Studies Facility (ESF) during working hours (with active ventilation) range from 0.22 to 72 pCi/L, with a median concentration of 6.5 pCi/L. Sections 4.1.2.2.2 (Environmental Consequences of Repository Construction, Operation and Monitoring, and Closure—Radiological Impacts to Air quality from Construction) and G.2.3.1 (Air Quality—Release of Radon-222 and Radon Decay Products from the Subsurface Facility) of the DEIS report that radon concentrations in the ESF during working hours with the ventilation system on range from 0.65 to 163 pCi/L, with a median concentration of 24 pCi/L. The difference is a factor of 2-3 in the range and a factor of approximately 4 for the median.

Section 4.1.7.3.1 [Environmental Consequences of Repository Construction, Operation and Monitoring, and Closure—Occupational Impacts (Involved and Non-Involved Workers)] of the DEIS states that "radiological health impacts to surface workers would be independent of the thermal load scenarios." However, it is not apparent whether there was any consideration of higher heat loadings increasing the radon release rate from the wall surfaces. Table G-48 of the DEIS reports that the annual average radon releases during the 24-yr operation period are expected to be 880 Ci, 1000 Ci, and 1900 Ci for the high, intermediate, and low thermal loads. It also appears that these source terms did not take into account the relative volume of the repository under each heat loading alternative.

Recommendation:

The FEIS should explain or address inconsistencies related to the appropriate range for ^{222}Rn concentration. The FEIS should also discuss the effects of the various heat loading scenarios on total radon release and provide a technical basis for the conclusion that radiological health impacts are independent of thermal load scenarios.

19... **NO ACTION ALTERNATIVE**

13. **Comment:**

The DEIS presents two scenarios, both of which DOE recognizes as unlikely, as a baseline to address the uncertainty associated with the management of SNF and HLW in the absence of a Yucca Mountain repository. Scenario 1 is a status quo of maintaining storage facilities continuously for the next 10,000 years. Scenario 2 proposes that these storage facilities would be maintained for 100 years, after which the 77 sites would be left without further management. Scenario 2 is not reasonable and, therefore, DOE should explain that it includes this scenario only to allow comparison with the analysis of the postclosure performance of the potential repository, which similarly is based on the highly unlikely and unreasonable assumption that institutional controls will be maintained only for 100 years.

Basis:

Scenario 2 assumes that, after a 100 year period, the Federal Government would permit SNF and HLW to be abandoned. This is not a reasonable assumption. The Federal

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19 cont. Government would continue to control licensed material and HLW under its authority for as long as necessary for public health and safety considerations.

Recommendation:

DOE should explain the basis for its identification of Scenario 2 as a potential no-action alternative.

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RESPONSES TO U.S. NUCLEAR REGULATORY COMMISSION COMMENTS ON THE DRAFT EIS (Comment Document 1898)

1. DOE has an ongoing program to address Nuclear Regulatory Commission comments on the Viability Assessment and other technical issues, largely as they have been translated into its comprehensive listing of scientific modeling issues in the Commission's Issue Resolution Status Reports (see, for example, DIRS 135160-Bell 1996; DIRS 154605-NRC 2000). Not all technical issues raised by the Commission are closed, but DOE has made and will continue to make a good faith effort to address each issue to the extent practicable. As reported in the Final EIS, the Department has made a number of modifications to the design of the repository and to the Total System Performance Assessment model that address Commission concerns. As of September 2001, the Key Technical Issues have all been declared "Closed-Pending" by the Commission.

   DOE has made a similar best effort to address the status of model validation and data quality assurance. The Department recognizes that it needs to apply a rigorous and effective quality assurance program, and that doing so will be crucial to demonstrating the validity of findings and analyses in any License Application. In response to previous Nuclear Regulatory Commission comments in this area, DOE has established a schedule for achieving quality assurance goals by the time of the License Application, if Yucca Mountain is found suitable and approved for development of a repository. DOE has met interim quality assurance goals for the Site Recommendation phase.

   In the September 6, 2001, Quarterly Meeting with the Nuclear Regulatory Commission, DOE outlined the transition plans for the respective quality assurance programs which would support becoming a licensee. The Commission indicated further evaluation of implementation of these plans would take place in approximately 6 months.

2. In the Final EIS, DOE has identified and analyzed a higher-temperature operating mode and a range of lower-temperature operating modes. Chapter 2 and other related sections of the Final EIS have been revised to reflect this refinement in design selection, which basically is an establishment of design fundamentals such as drift layout, drift spacing, depth and location of emplacement areas, and location of ventilation raises. The Final EIS describes a design for the repository with variations on the operating mode. The key parameters defining the operating mode are package spacing, drift temperatures, length of active ventilation, and age of the fuel being emplaced. The range of variances in these parameters basically determine the extent of the repository design that will be utilized for the emplacement of the 70,000 metric tons of waste and fuel; the higher-temperature operating mode would require only the main central segment of the repository; several of the lower-temperature operating modes would use that segment and the western extension, while the "ultra" low-temperature operating modes would require use of the entire planned initial design. In this way, DOE has focused its analysis on a more clearly defined proposal, and demonstrated that the environmental impacts of the construction and operation of the proposed repository would not be likely to exceed the upper range of the estimated impacts. Tables in Chapter 2 of the EIS demonstrate the bounding nature of the flexible operating modes within construct of a fixed design.

3. The Final EIS addresses the relevant technical issues DOE received in comments from the Nuclear Regulatory Commission relative to specific technical issues and the *Viability Assessment of a Repository at Yucca Mountain* (DIRS 101779-DOE 1998).

4. In the Draft EIS and the Supplement to the Draft EIS, DOE analyzed a variety of scenarios that offer a range of options for implementing the Proposed Action to construct, operate (including transportation) and monitor, and eventually close a repository at Yucca Mountain. These scenarios, which reflect potential design considerations, waste packaging approaches, and modes for transporting spent nuclear fuel and high-level radioactive waste to the Yucca Mountain site, considered the range of the environmental impacts likely to result from the Proposed Action.

   In the Final EIS, DOE has identified and analyzed a range of operating modes from higher- to lower-temperature. The lower-temperature analytical scenario considered six cases. Chapter 2 of the EIS and other

related sections of the Final EIS have been revised to reflect this refinement in design selection, which basically is an establishment of design fundamentals such as drift layout, drift spacing, depth and location of emplacement areas, and location of ventilation raises. The Final EIS describes a design for the repository with variations on the operating mode. The key parameters defining the flexible operating modes are package spacing, drift temperatures, length of active ventilation, and age of the fuel being emplaced. The range of variances in these parameters basically determine the extent of the repository design that will be utilized for emplacement of 70,000 metric tons of heavy metal of spent nuclear fuel and high-level radioactive waste; the higher-temperature operating mode would require only the main central segment of the repository; the lower-temperature operating mode could use that segment and the western extension, and could possibly require use of the entire available emplacement area. DOE has focused its analysis on a more clearly defined proposal, and demonstrated that the environmental impacts of the construction and operation of the proposed repository would not be likely to exceed the upper range of the estimated impacts.

DOE believes that the information in the EIS on the potential direct, indirect, and cumulative impacts that could result from the Proposed Action is sufficient. This belief is based on the level of information and analysis, the analytical methods and approaches used to represent conservatively the reasonably foreseeable impacts that could occur, and the use of "bounding assumptions" if information is incomplete or unavailable and if uncertainties exist.

For the same reasons, DOE believes that the EIS provides the information necessary to make decisions on the basic approaches to transporting spent nuclear fuel and high-level radioactive waste (such as mostly rail or mostly truck shipments), as well as the choice between alternative rail corridors in Nevada. However, follow-up implementing decisions, such as the selection of a specific alignment in a corridor, the specific location of an intermodal transfer station, or the need to upgrade heavy-haul truck routes, would require field surveys, State and local government consultations, environmental and engineering analyses, and National Environmental Policy Act reviews.

5. Since the issuance of the Draft EIS, the Department has continued to evaluate actions in the region of influence that could pose a potential cumulative impact. As a result of these reviews, the Department identified several new actions for which information was not available for the Draft EIS. These actions come from several agencies and private companies. For instance, Section 8.1.2.2 of the Final EIS contains an expanded discussion of the Timbisha Shoshone Homeland Act, along with possible implications to groundwater rights. Chapter 8 also contains discussions of other actions by the Bureau of Land Management (e.g., the Ivanpah Cargo Airport, the Moapa Paiute Energy Center); these actions were considered when evaluating the cumulative impacts for the technical discipline areas.

   As part of the updated analyses, the Department has expanded the land-use discussion in Chapter 8 to address specifically the known actions that have been identified since the publication of the Draft EIS. Where possible, the Department has identified changes in land use along with estimates of area to be disturbed and possible impacts with other actions in the area. In addition, all discipline areas (for example, biological resources and cultural resources) were reviewed to ensure that the appropriate level of discussion was included to address the potential cumulative impacts of all the actions. However, not all actions could be evaluated to the same level of detail because information was not always available to allow an in-depth evaluation.

6. DOE believes that the EIS adequately analyzes the environmental impacts that could result from the Proposed Action. This belief is based on the level of information and analysis, the analytical methods and approaches used to represent conservatively the reasonably foreseeable impacts, and the use of bounding assumptions where information is incomplete or unavailable, or where uncertainties exist. The use of widely accepted analytical tools, latest reasonably available information, and cautious but reasonable assumptions offer the most appropriate means to arrive at conservative estimates of transportation-related impacts.

   For the reasons discussed above, DOE believes that the EIS provides the environmental impact information necessary to make certain broad transportation-related decisions, namely the choice of a national mode of transportation outside Nevada (mostly rail or mostly legal-weight truck), the choice among alternative transportation modes in Nevada (mostly rail, mostly legal-weight truck, or heavy-haul truck with use of an associated intermodal transfer station), and the choice among alternative rail corridors or heavy-haul truck

routes with use of an associated intermodal transfer station in Nevada. DOE has identified mostly rail as its preferred mode of transportation, both nationally and in Nevada. At this time, however, the Department has not identified a preference among the five candidate rail corridors in Nevada.

If the Yucca Mountain site was approved, DOE would issue at some future date, a Record of Decision to select a mode of transportation. If, for example, mostly rail was selected (both nationally and in Nevada), DOE would identify a preference for one of the rail corridors in consultation with affected stakeholders, particularly the State of Nevada. In this example, DOE would announce a preferred corridor in the *Federal Register* and other media. No sooner than 30 days after the announcement of a preference, DOE would publish its selection of a rail corridor in a Record of Decision. A similar process would occur in the event that DOE selected heavy-haul truck as its mode of transportation in Nevada. Other transportation decisions, such as the selection of a specific rail alignment within a corridor, would require additional field surveys, State and local government and Native American tribal consultations, environmental and engineering analyses, and appropriate National Environmental Policy Act reviews.

In this EIS, DOE has used computer models it has used in previous EISs and other studies. These models are widely accepted by the national and international scientific and regulatory communities. For instance, DOE selected the RADTRAN 5 computer program to estimate radiological impacts to populations from incident-free transportation and from accidents. RADTRAN, which was originally developed by Sandia National Laboratories in the late 1970s, has been used in many other previous DOE EISs, and it has undergone periodic review and revision. In 1995, an independent validation review of RADTRAN 4 (immediate predecessor to RADTRAN 5) demonstrated that it yielded acceptable results when compared to "hand" calculations. More recently, an independent review found that RADTRAN 5 overestimates the measured radiation dose to an individual from moving radiation sources.

To ensure that the EIS analyses reflect the best latest reasonably available information, DOE has either incorporated information that has become available since the publication of the Draft EIS or modified existing information to accommodate conditions likely to be encountered over the life of the Proposed Action. For example, the analysis in the Draft EIS relies on population information from the 1990 Census. In this Final EIS, DOE has scaled impacts upward to reflect the relative state-by-state population growth to 2035, using 2000 Census data.

Although the EIS analyses are based on the best latest reasonably available information and state-of-the-art analytical tools, not all aspects of incident-free transportation or accident conditions can be known with absolute certainty. In such instances, DOE has relied on conservative assumptions that tend to overestimate impacts. For instance, DOE assumed that the radiation dose external to each vehicle carrying a cask during routine transportation would be the maximum allowed by U.S. Department of Transportation regulations. Similarly, DOE assumed that an individual, the "maximally exposed individual," would be a resident living 30 meters (100 feet) from a point where all truck shipments, or 200 meters (660 feet) from a point where all rail shipments would pass. Under these circumstances, the maximally exposed individual would receive a dose of about 6 millirem from exposure to all truck shipments, and a dose of about 2 millirem from exposure to all rail shipments (6 millirem represents an increased probability of contracting a fatal cancer of 3 in 1 million). Although it can be argued that individuals could live closer to these shipments, it is highly unlikely that an individual would be exposed to all shipments over the 24-year period of shipments to the repository, even though DOE incorporated this highly conservative assumption in the analysis.

7. At present, DOE does not have definitive information on specific tracts of land or community elements that the Proposed Action could affect, so it is premature to identify specific mitigation measures categorically. If the repository was approved, however, DOE would have discussions with potentially affected units of local government and consider appropriate support and mitigation measures. DOE would also continue its ongoing interactions with Native American tribes. In addition, specific mitigation measures could be part of a Mitigation Action Plan or similar plan, such as terms and conditions to Biological Opinions from the U.S. Fish and Wildlife Service and Nuclear Regulatory Commission licensing conditions. DOE, in submitting an application to construct and operate a repository, would identify relevant mitigation measures to the Commission for its consideration, and could reasonably expect a comprehensive set of mitigation measures or conditions of approval to be part of any licensing process. At this time, DOE has not decided whether to

prepare a Mitigation Action Plan. As described in Chapter 9 of the EIS, DOE intends to commit to reasonable management actions required to mitigate potential adverse environmental impacts. The Department would develop mitigation actions in cooperation with potentially affected units of local government

Section 116(c)(2)(A)(i) and (ii) of the NWPA state that "the Secretary shall provide financial and technical assistance to the State of Nevada and any affected unit of local government…to mitigate the impact on such State [Nevada] or affected unit of local government of the development of [a] repository and the characterization of [the Yucca Mountain] site." Such assistance can be given to mitigate likely "economic, social, public health and safety, and environmental impacts." Within that broad framework, neither Section 116 nor any other provision of the NWPA limits the impacts that are subject to assistance under Section 116 to the environmental impacts considered in this EIS. This section also allows payments to the State of Nevada and to any affected unit of local government equal to taxes they would have received if the activity was performed by a non-Federal entity.

Under the NWPA, the Section 116 impact assistance review process and the Yucca Mountain Repository EIS process are distinct from one another, and the implementation of one would not depend on the implementation of the other. Thus, the provision of assistance under Section 116 would not be limited either by the impacts identified in this EIS or by its findings on such impacts. A decision to provide assistance under Section 116 would be based on an evaluation of a report submitted by an affected unit of local government or the State of Nevada pursuant to Section 116 to document likely economic, social, public health and safety, and environmental impacts. Similarly, Section 180(c) of the NWPA requires the Secretary of Energy to provide technical assistance and funds for training public safety officials of appropriate units of local government and Native American tribes through whose jurisdictions DOE would transport spent nuclear fuel and high-level radioactive waste.

Mitigation measures discussed in the EIS include those for water use (Sections 9.2.3 and 9.3.3), cultural resources (Sections 9.2.5 and 9.3.5), biological resources (Sections 9.2.4 and 9.3.4); and public health and safety (Sections 9.2.6 and 9.3.6). Chapter 9 discusses impacts in addition to the areas mentioned in this comment. Conversely, DOE has generally not proposed mitigation measures in areas where analyses did not identify consequential impacts. In some instances, an analysis might reveal impacts for which there would be no practical mitigation measures. Decisionmakers would consider the unmitigated consequences in weighing the need for the project against the potential for adverse consequences.

With regard to this comment's example of mitigative measures for Native American interests, DOE supported the preparation of the American Indian Writers Subgroup document (DIRS 102043-AIWS 1998) and used it as a primary reference to the EIS (see Sections 3.1.6.2.2 and 4.1.13.4). DOE would include avoidance of significant archaeological sites as a mitigative action where feasible. If avoidance was not feasible, a data recovery effort would preserve the archaeological data. In addition, DOE would implement Section 180(c) of the NWPA, which requires the Secretary of Energy to provide technical assistance and funds for training public safety officials of appropriate units of government and Native American tribes through whose jurisdictions transportation of spent nuclear fuel and high-level radioactive waste would occur. The training would cover procedures for safe routine transportation and for dealing with emergency response situations.

Since issuing the Draft EIS, DOE has continued to evaluate design features and operating modes that would reduce uncertainties in or improve long-term repository performance, and would improve operational safety and efficiency. The result of the design evolution process was the development of the flexible design (which the Supplement to the Draft EIS called the Science and Engineering Report Flexible Design). Although this design focuses on controlling the temperature of the rock between the waste emplacement drifts (as opposed to areal mass loading) the basic elements of the Proposed Action to construct, operate and monitor, and eventually close a geologic repository at Yucca Mountain remain unchanged.

DOE would monitor impacts during the construction and operation of the repository. A postclosure monitoring program, required by 10 CFR Part 63, would include monitoring activities around the repository after closure. The regulation requires submittal of a license amendment for permanent closure of the repository [10 CFR 63.51(a)(1) and (2)]. This amendment must provide an update of the assessment for repository performance for the period after permanent closure, as well as a description of the program for postclosure monitoring. This

program would include continued oversight to prevent any activity at the site that posed an unreasonable risk of breaching the repository's engineered barriers or increasing the exposure of individual members of the public to radiation beyond allowable limits. The details of this program would be defined during the processing of the license amendment for permanent closure. Deferring final development of this program until the closure period would enable a more complete understanding of the circumstances of the repository at closure and incorporation and use of new technologies that could become available by closure.

8. DOE determined that it is not necessary to examine the composition of the general population residing along existing spent nuclear fuel and high-level radioactive waste transportation corridors before DOE can reasonably conclude that there would be no disproportionately high and adverse impacts to minority and low-income populations from the transportation of radioactive materials. In addition, as described in Chapter 6 of the EIS, incident-free transportation and the risks from transportation accidents (the maximum reasonably foreseeable accident scenario would have 2.3 chances in 10 million of occurring per year would not present a large health and safety risk to the population as a whole, or to workers or individuals along national transportation routes. The low effect on the population as a whole also would be likely for any segment of the population, including minorities, low-income groups, and members of Native American tribes.

   In response to comments, DOE also considered locations at which individuals could reside nearer to the candidate rail corridors and heavy-haul truck routes in Nevada as a way of representing conditions that could exist anywhere in potentially affected communities. For purposes of analysis, DOE assumed that a maximally exposed individual could reside or work as close as 4.9 meters (16 feet) to a potential heavy-haul truck route and 30 meters (98 feet) to a rail corridor. During the 24-year period of repository operations, if every shipment of spent nuclear fuel and high-level radioactive waste passed by these maximally exposed individuals, the would receive an estimated dose ranging from about 2 millirem (increased fatal cancer probability of 1 in 1 million) for rail shipment to about 29 millirem (increased fatal cancer probability of 2 in 100,000) for heavy-haul shipments.

   These exposures would be well below those received from natural background radiation, would not be discernible even if corresponding doses could be measured, and would not add measurably to other impacts that an individual could incur. For comparison, the lifetime likelihood of an individual incurring a fatal cancer from all other causes is about 1 in 4.

   However, the Final EIS examines the composition of the population along candidate rail corridors in Nevada. Selecting among alternative new routes may offer opportunities to avoid high and adverse impacts that would fall disproportionately on low-income or minority populations relative to the general population that would not be present when considering existing transportation corridors. Therefore, even though the health effects from exposure to radioactive materials from transportation activities would not implicate environmental justice concerns in selecting new routes, other factors such as the impacts of the construction and use of a newly created route on land use, socioeconomics, noise, air quality, and esthetics may vary by location. In response to comments, DOE has updated and refined information germane to the environmental justice analysis. For example, the EIS now includes additional and more detailed mapping and information that describes the proximity of tribal lands to rail corridors in Nevada. Section 6.3.4 of the Final EIS presents the analysis of environmental justice impacts in Nevada.

9. Federal Reserve Water Rights are noted in the footnote to Table 3-11, but are not quantified because they are not directly comparable to water appropriations authorized by the State of Nevada. As stated in the *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (DIRS 101811-DOE 1996), the Federal Reserve Water Rights position is that the Nevada Test Site is "…entitled to withdraw the quantity of water necessary to support the NTS missions." The Nevada Test Site EIS does not quantify or limit these rights, except for their purpose, and the repository EIS concurs with this view. With respect to identifying committed water resources, the repository EIS is obligated to identify cumulative impacts of other Federal and non-Federal actions. Chapter 8 discusses the past, present, and foreseeable future actions and associated water demands. In this manner, the EIS does indirectly identify quantities of water expected to be associated with reserved water rights (that is, if their impacts would be cumulative with those of the Proposed Action).

The purpose of Table 3-11 of the Draft EIS and its associated text is not to suggest that ample water is available. The intent is only to describe existing groundwater resources and use in the region of Yucca Mountain. DOE agrees that average withdrawals do not tell the entire story when looking at groundwater resources and their availability. This is the reason that both water appropriations and estimates of perennial yield are also shown in the table. In addition, DOE understands, though not expressed in the EIS, that the State Engineer must consider factors in addition to those shown in the table when considering requests for water appropriations.

Chapter 8 of the EIS describes the cumulative impacts of groundwater use by the Nevada Test Site, Nellis Air Force Range, and the proposed repository. Additional text has been added to Section 8.2.3.2 to better address other uses of groundwater in the area. As identified in Section 4.1.3.3, the peak projected annual water demand for the proposed action [360,000 cubic meters (290 acre-feet)], when combined with projected demand from the Nevada Test Site [350,000 cubic meters (280 acre-feet)], would approach, but would not exceed, the lowest estimate of perennial yield for the western two-thirds of the Jackass Flats hydrographic area [720,000 cubic meters (580 acre-feet)]. The corresponding discussion in Section 4.1.3.1 of the EIS (impacts from performance confirmation) is intentionally brief because of the relatively small annual water demand projected for that phase of the project. The evaluation in this section compares projected water demand to the perennial yield estimates and shows them to be minor. The addition of the Nevada Test Site demand would still put projected water withdrawals well below the lowest estimates of perennial yield, which were not mentioned.

With respect to the wide range of perennial yield figures identified for hydrographic area 227a, an explanation of the origin and basis for each of these numbers is beyond the scope of the EIS. A partial answer is that estimates of recharge are difficult and vary widely in this area where evapotranspiration is high and quantities of surface water are low. An order of magnitude difference between recharge estimates for the same study area is not unusual in the literature. The source of the perennial yield information presented in Table 3-11 of the Draft EIS is in a footnote to the table. The cited source identifies the studies from which the perennial yield values are taken and discusses those studies. The EIS recognizes that the Nevada Division of Water Planning uses an estimate of perennial yield that is not totally consistent with those listed in Table 3-11. Tables 3-35 and 3-43 of the Draft EIS both include a footnote indicating that the Nevada Division of Water Planning uses a combined perennial yield of 30 million cubic meters (24,000 acre-feet) for hydrographic areas 225 through 230. This estimate was not used in the tables because it has not been divided into the individual areas. DOE thought it important to give estimates and discuss perennial yield based on these smaller areas, so it used the best available data (on an individual hydrographic area basis). DOE believes that the EIS considers a wide range of perennial yield values, particularly for hydrographic area 227a (Jackass Flats), and that this is appropriate and conservative. The fact that the Nevada Division of Water Planing uses different values for some of the committed resources is due to the use of a more recent reference in the EIS (DIRS 103406-NDWP 1992).

As indicated above, Chapter 8 of the EIS discusses other (nonrepository) water demands in the Yucca Mountain region. However, Section 4.1.3.3 does clearly indicate that there would be an ongoing Nevada Test Site water demand from the same hydrographic area from which the Yucca Mountain Site Characterization Project would be withdrawing water. This section does not mention water demands for the Nellis Air Force Range because there are no demands in this hydrographic area. It does discuss the potential for overdraft of this hydrographic area. This hydrographic area (227a – Jackass Flats) is not an isolated basin. It receives water both from the surface (recharge from precipitation) and as underflow from upgradient areas. It also loses water as underflow to downgradient areas. As described in the EIS, withdrawing only slightly more water than the low estimate of perennial yield (which is based solely on recharge from local precipitation) would be unlikely to cause a depletion of the reservoir because of the higher quantities estimated to be moving through as underflow. However, it would probably result in a minor shifting of the general groundwater flow patterns to compensate. Since the publication of the Draft EIS, two groundwater modeling efforts have been completed to simulate the effects of the projected water demands by the repository on the groundwater flow system. The Final EIS has been modified to discuss the results of these efforts, which are consistent with the general impacts discussed above.

As indicated above, effects of overdrafting within Jackass Flats are discussed in this EIS and modifications have been added to the Final EIS to address the results of applicable modeling efforts. With respect to the Amargosa Desert, Section 4.1.3.3 of the EIS states that water demand associated with the proposed repository would have only a small impact on water availability in Amargosa Desert. That is, actual or potential overdrafting of

groundwater in the Amargosa Desert would be attributed predominantly to pumping in that area and would not be substantially affected by the amount of water needed to support the repository. Accordingly, possible impacts from overdrafting in Amargosa Desert are not discussed in the EIS. Overdrafting at Yucca Flat is not described in the EIS because it does not have a direct connection to the Proposed Action. Figure 3-13 of the Draft EIS shows that Yucca Flat is within the Ash Meadows Groundwater Basin and the direction of groundwater flow from there is toward Frenchman Flat and eventually to the Ash Meadows area and, if remaining as underflow, to the Amargosa Desert. This is consistent with the State of Nevada report *Water for Nevada* (DIRS 103016-State of Nevada 1971), which shows no groundwater inflow to this hydrographic area (area 159 – Yucca Flat), but does show its groundwater outflow going to Frenchman Flat, which also receives underflow from adjacent areas. The Nevada Test Site withdraws water from Frenchman Flat (hydrographic area 160), but at quantities far below its perennial yield (DIRS 101811-DOE 1996). Based on this picture of groundwater flow conditions, overdrafting at Yucca Flat would be expected to result in very localized conditions, probably not even extending far into Frenchman Flat because the combined water use for these two areas (Yucca and Frenchman Flats) is only a small fraction of their combined perennial yield [1.8 million cubic meters (1,400 acre-feet) of peak annual water demand versus 16,350 acre-feet of perennial yield (DIRS 101811-DOE 1996)]. Any affects on the groundwater flow from Yucca Flat overdrafting would surely be lost by the time groundwater flow reaches the southern end of the Amargosa Desert where impacts could be cumulative with those of the Proposed Action. Accordingly, Chapter 8 discusses impacts of the total water demand and cumulative impacts from the Nevada Test Site and the Proposed Action and does not address noncumulative issues that are internal to the Test Site.

10. The EIS identified a land withdrawal area in Section 3.1.1.3 to comply with regulations issued by the Nuclear Regulatory Commission concerning land ownership and control for a repository at Yucca Mountain (10 CFR Part 63). The safety of the repository requires DOE to demonstrate with a reasonable expectation that the long-term performance of the repository can meet the environmental radiation-protection standards established by the Environmental Protection Agency (40 CFR Part 197). Essentially all of the land identified for withdrawal (that is, about 229 out of 230 square miles) is Federal land. About 1 square kilometer at the southern end is private land. There is no State land or tribal land within the withdrawal area. If Congress withdrew the land for a repository as discussed in Section 4.1.1.1 of the EIS, it could specify conditions for other land uses as part of the withdrawal. The land withdrawal could eliminate currently existing opportunities for multiple use, including recreation, mineral exploration and mining. Because the lands within the withdrawal area do not have unique characteristics that have historically attracted the public, and because large tracts of public land occur nearby, DOE believes that the impacts to people who use this land would be negligible. DOE acknowledges in the EIS that Native Americans consider the intrusive nature of the repository to be an adverse impact to all elements of the natural and physical environment.

11. The statement in the Draft EIS on page 5-47, "There is considerable uncertainty in the estimates of soil temperature increases due to uncertainties in the thermal properties of the soil…" is misleading. There are some uncertainties in the thermal properties of the soil but these do not cause "considerable uncertainty" in the estimates of soil temperature increase. DOE has revised the text of the EIS to reflect this. While the Department acknowledges that some uncertainties exist in thermal properties of Yucca Mountain soils, the EIS modeling effort used the best available information for predicting average soil temperature increases. The model did not use the weekly to monthly soil temperatures to which the commenter refers because the time scale "could not be used to accurately estimate the soil thermal conductivity" (DIRS 103618-CRWMS M&O 1999). Rather, it used only hourly soil temperature measurements, which allowed the use of diurnal fluctuations to estimate the thermal diffusivity of the soil and provided a calibration for the thermal diffusivities modeled for wet, dry, and nominal soils. The thermal diffusivity obtained from the hourly soil temperature measurements was similar to that estimated for soils under wet conditions. Therefore, the thermal diffusivity estimated for dry soil represents a conservative value on predicted soil temperature increase, and the "available data suggest very modest temperature rises due to repository heat effects" (DIRS 103618-CRWMS M&O 1999). DOE has revised the EIS to clarify the reasons why dry soil thermal conductivity provides a conservative prediction of soil temperature increase. Temperature changes used to evaluate impacts were based on dry soils, and therefore cover the range of possible effects of soil warming on desert tortoises and other biological resources.

As described in Section 5.9 of the EIS, based on these conservative calculations, the predicted increase in soil temperature at the shallow depth at which tortoises lay eggs would be very small compared to the range of natural variation in soil temperatures at Yucca Mountain (DIRS 105031-CRWMS M&O 1999) and the range of temperatures at which desert tortoise eggs have been successfully incubated. This small change in temperature, therefore, should have no adverse affect on tortoise eggs. Because of this and the small size of the affected area [about 3 square kilometers (740 acres)], DOE believes that impacts to the desert tortoise from heat generated by the proposed repository would be minimal.

12. DOE does not believe that quantitative analysis is either missing or required to conclude that the Proposed Action would have little effect on biological resources at Yucca Mountain. As stated in Section 4.1.4 of the EIS, the most important impacts of repository construction and operation on desert plants and animals would be the disturbance of about 3 to 7 square kilometers (about 800 to 1,700 acres) of land and the continuation of traffic and human presence. These activities would occur in a region with few other disturbances and would affect species that are common and widespread throughout the region. DOE based the conclusion that the Proposed Action would have little effect on desert tortoises on detailed site-specific research on the tortoise populations at Yucca Mountain during site characterization. That research confirmed that activities similar to those proposed have little effect on adjacent populations. DOE has modified Sections 4.1.4.1 and 4.1.4.2 of the EIS to better explain its conclusions about impacts to desert tortoises.

    The withdrawal of land surrounding the repository would protect a substantial area near the edge of the range of the tortoise from potential stressors that could occur if the land in the withdrawal area was developed for other uses.

13. The Final EIS presents the baseline information for economic measures to 2035. The intent of the cited statement in Section 4.1.6.2.1 is that there would not be a significant decline in the economy due to the closure of the repository. It does not indicate that individual workers might not be absorbed into the local economy fully using their "repository skills." This would be no different than the closure of any workplace, such as a manufacturing facility, where displaced employees might have to change occupations or move, although the impacts to the local economy might be small.

14. This comment takes issue with Section 6.3.2.2.1 of the EIS, which indicates "[t]he projected length of the corridor – 513 kilometers (319 miles) – is the most important factor for determining the number of workers [560] that would be required." Because DOE based the identification of the alternative corridors on a range of factors including land ownership, engineering, and terrain or steepness of grade, the length of the corridor inherently reflects of the weighing and balancing of these other factors. As a consequence, the length of a branch rail line would influence the number of workers required and worker productivity because of the engineering requirements and possible routing constraints in the initial layout of the corridor.

    With regard to the socioeconomic analyses in which the cited statement appears, the number of workers is the fundamental parameter for estimating other potential changes to the economy such as Gross Regional Product, disposable income, and State and local spending.

15. The EIS evaluated potential impacts from a regional volcanic eruption. Section H.2.1.3 of the EIS concludes that 3 centimeters (about 1.2 inches) is the maximum thickness of tephra (solid material; ash) from a "regional volcanic eruption, which is more likely," that could be deposited on repository facilities. Analyses to date indicate that such an event would not affect structures such as the Waste Handling Building, where DOE would process casks.

    The EIS analysis used a thickness-versus-distance curve from Miller et al. (DIRS 152166-1982). This curve shows that ash from the Long Valley Caldera/Mono-Inyo Volcanic area [about 250 kilometers (155 miles) west of Yucca Mountain] would deposit about 1 centimeter (0.4 inch) of ash at the proposed repository. The same volume of material from an eruption in the closer Coso Volcanic Field [about 150 kilometers (93 miles) southeast of Yucca Mountain] would deposit 2 to 3 centimeters (0.8 to 1.2 inches) of volcanic ash at the repository (DIRS 102889-Perry and Crow 1990).

16. Supporting analyses or references related to issues in this comment are available in the *Environmental Baseline File: Archaeological Resources* (DIRS 104997-CRWMS M&O 1999). That document includes a bibliography of cultural resource reports that contain specific details requested by the commenter. These documents are available from the Yucca Mountain Project Public Reading Room. DOE believes the level of information provided in the EIS is sufficient for decisionmakers to understand the issues and potential for impacts on archaeological and cultural resources.

    Archaeological field studies in support of the Yucca Mountain Project have been conducted since 1982 by the staff of the Desert Research Institute. Based on project needs during this period, several methodologies have been employed to characterize and protect archaeological sites and data. These include (1) use of existing archaeological data from previous projects, (2) intensive archaeological field surveys and limited subsurface testing, (3) preactivity surveys at areas ahead of planned ground-disturbing activities for areas lying outside of the acreage surveyed under the previous category, (4) data recovery, (5) random sample unit surveys for larger tracts outside the withdrawal area, and (6) archaeological site monitoring to assess changes to significant sites over time.

    Specific field methods and techniques employed at Yucca Mountain are outlined in the following documents:

    1. *Programmatic Agreement Among the United States Department of Energy, The Advisory Council on Historic Preservation and the Nevada State Historic Preservation Officer for the First Nuclear Waste Deep Geologic Repository Program, Yucca Mountain, Nevada*. (DIRS 157145-Gertz 1988)

    2. *Research Design and Data Recovery Plan for Yucca Mountain Site Characterization Project* (DIRS 103196-DOE 1990)

    3. *Environmental Field Activity Plan for Archaeological Resources* (DIRS 103198-YMP 1992)

    4. *Branch Technical Procedures: Field Archaeology* (DIRS 157150-DRI 1990)

    In addition to these generic documents, several project-specific individual research designs have been prepared for individual field survey, testing, and data recovery efforts undertaken by the Desert Research Institute. Copies of these documents are available from the Desert Research Institute, DOE, and the State Historic Preservation Officer.

    DOE used the combined information derived from implementation of the methods noted above to provide the summarization for the EIS. While precise figures (number of acres) have not been compiled for the entire land withdrawal area, all areas associated with the repository site that have either been disturbed by past site characterization activities or that are proposed for disturbance during repository construction and operation have been inventoried for archaeological resources. Archaeological data for other parts of the larger withdrawal area have received varying levels of archaeological study, ranging from random sample unit surveys to intensive coverage associated with preactivity activities away from the repository site. In some instances, known archaeological site data also are derived from surveys conducted by other agencies and/or projects (for example, Bureau of Land Management, Nellis Air Force Base, and the Nevada Test Site) on lands not currently managed by the Yucca Mountain Project.

    All of the historic sites discussed in Section 3.1.6 of the EIS are associated with non-Native American occupation and use of the area. Section 3.1.6.2.2 discusses historic-period Native American sites, which are documented in the Native American resource document prepared by the Consolidated Group of Tribes and Organizations' American Indian Writers Subgroup (DIRS 102043-AIWS 1998).

17. The Draft EIS methodology for estimating source concentrations was detailed in Appendix I on pages I-15 to I-18 (Section I.3.2.3.1). This section describes in detail how the values in Tables I-11 and I-12 were developed using the EQ3/6 software. The values in Tables I-11 and I-12 were then used to develop the screening information in Table I-13 as explained in section I.3.2.3.2 (pages I-18 to I-19). This screening process determined which elements required more rigorous analysis (taking into account many other mitigating processes). Chemicals eliminated in the screening process demonstrated such low potential concentrations, in

these calculations, that more rigorous analysis (which would account for additional mitigating processes) was unnecessary to establish there would be no significant impacts. In the screening analysis, EQ6 simulations of the reaction of the solution resulting from corrosion with the host rock demonstrated that nearly all the dissolved nickel would precipitate (resulting in a concentration of only about 0.0001 milligram per liter) upon contact with the crushed tuff invert (see Draft EIS Table I-12 and accompanying discussion). For this reason, nickel was not considered further in the impact analyses. Detailed analysis for those chemicals not screened out are described in Section I.6 of the Draft EIS. This material was referred to in Chapter 5 of the Draft EIS on page 5-39.

The Final EIS analyzes the new waste package design (Alloy-22 outer shell with stainless-steel sleeve). The new analysis conservatively assumes the nickel reaction with tuff would not take place. As detailed in Section I.6 of the Final EIS, bounding calculations (not taking into account many mitigating processes) still indicate a nickel concentration producing only a small fraction of the oral reference dose for nickel.

18. These sections differed because some addressed exposure of workers during working hours, while others addressed the continuous exposure of members of the public. Sections 3.1.8.2 and F.1.1.6 are specifically concerned with the potential exposure of workers. Radon concentrations at points of exposure within the repository and several kilometers from repository ventilation exhaust are considerably different. The use in the Draft EIS was consistent and appropriate.

    The Final EIS uses more recent repository radon flux information that has become available since the Draft EIS was published. This new information has replaced much of the information used as the basis of estimates in the Draft EIS. Dose estimates to subsurface workers from radon decay products now use Working Level estimates made for the flexible design (DIRS 154176-CRWMS M&O 2000). Section F.1.1.6 of the Final EIS describes these dose estimates. Working Level estimates can be converted to estimates of dose using a published conversion factor (DIRS 103279-ICRP 1994). Dose estimates for members of the public are also based on new estimates of radon release from the repository, which take advantage of new analyses of ventilation and radon flux from the repository walls (DIRS 150246-CRWMS M&O 2000; DIRS 154176-CRWMS M&O 2000). Section 4.1.2 reports revised dose estimates for the public from radon.

    Information was not available for the Draft EIS to take into account the effect of heating of the emplacement drift walls by the waste packages. The analyses noted above have addressed the effect of heating (DIRS 154176-CRWMS M&O 2000), and the Final EIS takes this factor into account. All analysis scenarios for the Draft and Final EIS account for the effects of different repository sizes or volumes. A larger repository has a correspondingly larger radon release. However, the radon flux from repository walls and total radon release is not directly proportional to the total repository volume. Radon flux and release depend on the specific characteristics of the repository, including the relative quantity of larger-diameter excavations such as access mains, 5.5-meter (18-foot)-diameter excavations such as emplacement drifts, and smaller excavations such as ventilation raises. Radon release also depends upon the project phase, and whether or not a specific excavation would have a concrete liner (which would reduce radon flux).

    The statement in Section 4.1.7.3.1 of the Draft EIS that radiological health impacts in the "surface" facilities are independent of thermal load scenarios is unrelated to subsurface radon release. The bulk of dose to surface workers is due to handling of spent nuclear fuel, which depends on the facility throughput, (that is, 63,000 metric tons of heavy metal for the Proposed Action). The dose contribution from radon released from the subsurface is negligible. These statements remain correct for the Flexible Design evaluated in the Final EIS. Additional clarification on the contribution of subsurface radon to workers doses has been added.

    Sections G.2 and F.1.1.6 have been extensively revised in the Final EIS to present the new information noted above, as have the corresponding impacts in Sections 4.1.2 and 4.1.7.

19. DOE recognizes that neither No-Action scenario is likely to occur (see Section 2.2 and the introduction to Chapter 7 of the EIS). However, they were identified to provide a basis for comparison to the Proposed Action and because they reflect a range of potential impacts that could occur from the continued storage of material at these sites. For example, the impacts associated with the first 100 years of effective institutional control (either Scenario 1 or Scenario 2 of the No-Action Alternative) enable a direct comparison to the impacts of the

Proposed Action during the first 100 years after closure of the repository. For purposes of analysis and to be consistent with the Proposed Action, Scenario 2 does not assume credit for institutional control after approximately 100 years. Under this scenario storage facilities and spent nuclear fuel and high-level radioactive waste would degrade, and radioactive material would eventually enter the accessible environment. This assumption is based upon a review of generally applicable Environmental Protection Agency regulations for the disposal of spent nuclear fuel and high-level radioactive waste (40 CFR Part 191) and the National Academy of Sciences review of standards for the proposed Yucca Mountain Repository (DIRS 100018-National Research Council 1995). Each of these references generally discounts the consideration of institutional control for longer periods of performance assessments for geologic repositories.

Section K.4.1.1 of the EIS discusses the uncertainties associated with changes in societal values that could lead to the loss of institutional controls. Although these conditions might be difficult to imagine happening in the United States, they are not unlike what has occurred recently in the former Soviet Union and Germany prior to the end of World War II. The evaluation of Scenario 2 was not included in the EIS as a scare tactic. In fact, DOE took extreme care to avoid overestimating any impact from the No-Action Alternative. By intentionally using a realistic best estimate modeling approach (see Section K.1) and by not including all potential human exposure pathways (see Section K.3.1), DOE concludes that the impacts of such a scenario might have been underestimated by several orders of magnitude (Section K.4).

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

010248

June 29, 2001

RECEIVED
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Mr. Lake H. Barrett, Acting Director
Office of Civilian Radioactive Waste Management
U.S. Department of Energy, Headquarters
1000 Independence Avenue, S.W.
Washington, DC 20585

Dear Mr. Barrett:

As you know, the U.S. Department of Energy (DOE) published a notice of availability, in the Federal Register on May 4, 2001, of a supplement to its draft environmental impact statement (DEIS) (hereafter referred to as the SDEIS), for a proposed geologic repository for the disposal of spent nuclear fuel and other high-level radioactive waste (HLW) at Yucca Mountain in Nevada. In the context of the Nuclear Waste Policy Act (NWPA), as amended, DOE is the lead agency for developing the proposed repository and considering potential environmental impacts. For its part, NRC is to adopt DOE's final environmental impact statement (FEIS), to the extent practicable, as part of any potential NRC licensing action related to the repository.

Consistent with its NWPA responsibilities and its role as a DEIS commenting agency, the NRC provided comments to DOE on its DEIS in a letter dated February 22, 2000. NRC's comments on the recently published SDEIS are enclosed. The enclosed comments and NRC's February 2000 comments on the DEIS are provided to ensure that the FEIS is more complete.

Please contact Charlotte E. Abrams, of my staff, if you have any questions about this letter or the enclosure. Ms. Abrams can be reached at (301) 415-7293.

Sincerely,

Martin J. Virgilio, Director
Office of Nuclear Material Safety
and Safeguards

Enclosure:
"U.S. NRC's Comments on U.S. DOE's Supplement to the Draft Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada"

cc: Dr. Jane R. Summerson

See attached list

Letter to L.H. Barrett from M. Virgilio dated: June 29, 2001 **010248**

cc:

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U.S. NUCLEAR REGULATORY COMMISSION'S COMMENTS ON THE U.S. DEPARTMENT OF ENERGY'S "SUPPLEMENT TO THE DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR A GEOLOGIC REPOSITORY FOR THE DISPOSAL OF SPENT NUCLEAR FUEL AND HIGH-LEVEL RADIOACTIVE WASTE AT YUCCA MOUNTAIN, NYE COUNTY, NEVADA"

This enclosure provides comments, by the U.S. Nuclear Regulatory Commission (NRC) staff, on the May 2001 supplement to the draft environmental impact statement (DEIS) (hereafter referred to as the SDEIS) prepared by the U.S. Department of Energy (DOE) for a proposed geologic repository for the disposal of spent nuclear fuel (SNF) and other high-level radioactive waste (HLW) at Yucca Mountain (Nye County), Nevada.

In its review of the SDEIS, NRC has four comments, as noted below, that address the following areas: identification of a Proposed Action; impacts from the design options; new or modified facilities associated with the Science and Engineering Report (S&ER) flexible design; and the assessment of radiological impacts associated with the S&ER flexible design.

Comment No. 1

1 Consistent with its February 2000 comments on the DEIS, the NRC staff believes that DOE's final environmental impact statement (FEIS) should more clearly define a Proposed Action for each component of the proposed activity.

Basis:

The environmental impact statement development process is intended to address a wide range of possible impacts of this complex geotechnical project. A significant amount of information, including multiple options for key components of the Proposed Action, was presented in the August 1999 DEIS (U.S. Department of Energy, 1999). However, as noted in its February 2000 comments on the DEIS, the NRC staff continues to believe that DOE's final environmental impact statement (FEIS) should more clearly define a Proposed Action comprised of: (i) a preferred option for each component; or (ii) a bounding analysis that provides a better understanding of the potential impact of each component, as well as their combined impacts. NRC recognizes the utility of DOE's preserving, to the extent possible, repository design flexibility, as outlined recently in the S&ER supporting the DEIS and the SDEIS. However, the DEIS did not identify a preferred option for each component of a possible geologic repository and the SDEIS does not define a preferred option for the design of a repository. Consequently, it is not clear that environmental impacts that could arise from a repository have been bounded.

Recommendation

In the interest of improving the focus of its National Environmental Policy Act analysis in its FEIS, DOE should prepare an appropriate analysis of a clearly defined Proposed Action, or provide sufficient information and analysis of the various operational approaches to demonstrate that the environmental impacts of the proposed repository are bounded.

Enclosure

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Comment No. 2

2... The SDEIS provides several new design and operational features proposed to meet thermal criteria. DOE should ensure that sufficient information is provided to enable assessment of the direct, indirect, and cumulative impacts.

Basis

In the SDEIS, DOE describes two thermal operational approaches to control temperature at the drift pillars and the waste package surface. For the high-temperature operation mode, at least some portion of the drift pillars would have temperatures above the boiling point of water. The low-temperature operating mode is designed to ensure temperatures below the boiling point at all times and waste package surface temperatures below 85 degrees Centigrade. To achieve either temperature scenario, DOE describes five potential operational approaches: increased drift spacing, increased preclosure ventilation, surface aging of commercial fuel, fuel blending, and variable line loading. Depending on the approaches selected, the operational and monitoring period may extend beyond 300 years, with as long as 50 years allowed for waste emplacement.

NRC recognizes the value of maintaining flexibility in selecting operational approaches to enhance repository performance. However, many combinations of the operational approaches are likely to achieve the overall thermal goals, and each combination is likely to have a different set of impacts. For example, lower rates of ventilation may require larger spacing between waste packages, which may, in turn, lead to a larger repository with a greater volume of excavated rock and an expansion of the repository closer to key features such as the high ground-water gradient area to the north and across an additional fault zone. Similarly, the flexible pre-closure ventilation design could increase radon release through the use of forced ventilation. Without a clear description of the preferred option or without estimating impacts explicitly for each option, there is no basis for concluding that the full range of impacts has been presented in the DOE analyses.

Several of the flexible design operational approaches include new features not considered in the DEIS. In some instances, the SDEIS analyses multiply DEIS impacts by a proportionality constant to obtain impacts associated with the S&ER flexible design. Because many of the impacts cited in the SDEIS are the result of new design features (e.g., surface-aging facility, titanium drip shields) and altered time frames in the various flexible operational approaches, an adequate technical basis is required for use of the proportionality constants. For example, it is not clear that the thermal effects imposed by the flexible design would be linear and therefore amenable to quantification based on a proportionality constant. Similarly, impacts from constructing and operating the surface-aging facility may be spread over as many as 50 years, and include the construction of concrete pads covering 200 acres, and fabricating and placing up to 4500 dry-storage canisters and casks on these pads (Mattsson, 2000; U.S. Department of Energy, 2001a, Table 3-11). These new features are substantive modifications of the DEIS design and individual and cumulative impacts may not scale in a linear fashion .

The full range of impacts of the new operational approaches are not addressed. Waste package emplacement is discussed in detail in the SDEIS (Section 2.3.3.3), but certain potential activities are not discussed. They include, for example: (i) loading dry storage canisters and casks for the SNF aging facility; (ii) removing pallets and waste packages for repair and re-emplacement; (iii) maintaining drifts, waste packages, and other engineered barriers; (iv) moving waste packages to adjust thermal load; (v) retrieving waste packages; (vi) installing and maintaining drip shields; and (vii) constructing and using performance-confirmation drifts. It is also not clear whether the impact assessments include off-normal

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2 cont. events, accidents, or other events outside of the base case. For example, the impacts from manufacturing and shipping as much as 60,000 metric tons of fabricated titanium drip shields are not fully addressed, nor is the potential for worker injury or exposure during drip-shield emplacement. The drip shield is a new design feature and is not addressed in the offsite impact analyses included in the DEIS.

Recommendation
The FEIS should include an analysis of impacts associated with all potential operational activities related to a preferred design option. As an alternative, the FEIS could estimate impacts separately for a suite of proposed operational approaches. The specific environmental concerns associated with each primary impact indicator should be identified. The FEIS should also provide a technical basis to demonstrate that the full range of direct, indirect, and cumulative impacts has been included in the analyses. In addition, the FEIS should improve the technical justification for the use of linear thermal load proportionality factors.

3 **Comment No. 3**
The S&ER flexible design includes new or modified facilities, land uses, and changes in infrastructure. Environmental impacts from construction and operation of these repository features are not included in the SDEIS. A more thorough impact assessment is necessary for major changes incorporated in the S&ER flexible design.

Basis
The SDEIS (Table S-2) indicates that environmental impacts associated with the S&ER flexible design include potentially significant changes in ground use, radon release, peak electrical power requirements, fossil fuel requirements, construction and demolition debris, and waste generation. Although the SDEIS provides a relatively thorough description of the different approaches to the potential design and operating bounds of the proposed S&ER flexible design, a detailed description of these new facilities and analyses of their environmental impacts has not been included.

Foremost among the new facilities is the proposed separate, at-surface fuel-aging area. As part of the lower-temperature, flexible-design operating mode, DOE has proposed placing younger fuel in a surface-aging area, to allow heat dissipation before underground disposal, as a method of controlling repository temperatures (U.S. Department of Energy, 2001a, p. 2-8). This facility would age as much as 40,000 MTHM (metric tons of heavy metal) of SNF (or about 60 percent of repository-destined waste) over a 50-year period (Id.). Aging time is directly related to potential impacts associated with surface storage of SNF; however, only limited impact analysis of this new design feature has been provided in either the SDEIS or the S&ER. There is a similar concern regarding the proposed blending pool in the waste-handling building with a proposed design capacity of 5000 MTHM (p. 2-15). It is not apparent that DOE has prepared an impact analysis of this major new design feature.

Other examples of new design features that lack adequate descriptions and impact assessments (i.e., land and water use, impact on ground-water quality) include the solar power generating facility, and the wind farm. The environmental impacts of all features of a proposed design, as well as alternatives, need to be identified and evaluated.

Recommendation
DOE should expand the description and environmental impact analyses for major new features of the S&ER flexible design in the FEIS.

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Comment No. 4

4 Estimates of the radiological impacts of the flexible design require additional technical basis.

Basis

The SDEIS (U.S. Department of Energy, 2001a, Section 3.1.7) states that "[e]xposed workers include both radiation workers and some general employees.... DOE used the total number of exposed worker-years to estimate potential impacts from the radiation dose received from this exposure, namely the number of latent cancer fatalities...." The SDEIS does not define the number of general employees, the lengths of their exposures, or the exposure levels associated with different phases of operation that were applied in estimating latent cancer fatalities.

In addition, the lower-temperature design option may require preclosure ventilation for a period beyond 300 years. Ensuring that the emplacement drifts remain clear and unobstructed from rockfall or drift collapse during this period is therefore important. The SDEIS does not appear to address the impacts of drift support system maintenance on worker exposure.

Recommendation

The FEIS should provide a more complete assessment of the radiological impacts of the flexible design, including maintenance activities associated with an extended preclosure period.

References

Mattsson, C.G., "Repository Surface Design Engineering Files Letter Report – Non-Boiling Repository Surface Facilities Conceptual Design," Letter from C.G. Mattsson (Civilian Radioactive Waste Management System Management and Operating Contractor) to K.J. Skipper (DOE/Yucca Mountain Site Characterization Office), July 21, 2000.

U.S. Department of Energy, "Draft Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada," DOE/EIS–0250D, North Las Vegas, NV: Office of Civilian Radioactive Waste Management, U.S. Department of Energy, 1999.

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U.S. Department of Energy, "Yucca Mountain Science and Engineering Report: Technical Information Supporting Site Recommendation Consideration. DOE/RW–0539. Washington, DC: Office of Civilian Radioactive Waste Management, U.S. Department of Energy, 2001b.

U.S. Nuclear Regulatory Commission, "U.S. Nuclear Regulatory Commission's Comments on U.S. Department of Energy's Draft Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-level Radioactive Waste at Yucca Mountain, Nye County, Nevada," Washington, DC: U.S. Nuclear Regulatory Commission, 1999.

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RESPONSES TO U.S. NUCLEAR REGULATORY COMMISSION COMMENTS ON THE SUPPLEMENT TO THE DRAFT EIS (Comment Document 10248)

1. In the Draft EIS and the Supplement to the Draft EIS, DOE analyzed a variety of scenarios and implementing alternatives that it could deploy to construct, operate and monitor, and eventually close a repository at Yucca Mountain. The purpose of these scenarios and implementing alternatives, which reflect potential design considerations, waste packaging approaches, and modes for transporting spent nuclear fuel and high-level radioactive waste to the Yucca Mountain site, was to: (1) provide the full range of potential environmental impacts of the Proposed Action and No-Action Alternative; (2) reflect potential decisions, such as the mode of transport, that the EIS would support; and (3) retain flexibility in the design of the repository to maintain the ability to reduce uncertainties in or improve long-term repository performance, and improve operational safety and efficiency. The design and operation enhancements presented in the Supplement have been carried forward to the Final EIS.

   Many of the issues relating to how a repository would be operated and how the spent nuclear fuel and high-level radioactive waste would be packaged would be resolved only in the context of developing the detailed design for a possible license application. DOE cannot predict with certainty how it would eventually resolve these issues. However, to enable an improved understanding of the potential environmental impacts from a more specifically defined Proposed Action, DOE has identified its preferred alternatives, simplified aspects of the Proposed Action, and modified its analyses and presentation of information to illustrate the full range of potential environmental impacts likely to occur under any foreseeable mode of transportation, or repository design and operating mode. Thus, for example, DOE has identified rail as its preferred mode of transport both nationally and in Nevada, and demonstrated through analysis that the mostly truck and mostly rail national transportation scenarios provide the full range of environmental impacts.

   In the Final EIS, DOE has identified and analyzed a range of operating modes from higher- to lower-temperature. Chapter 2 of the EIS and other related sections of the Final EIS have been revised to reflect this refinement in design selection, which basically is an establishment of design fundamentals such as drift layout, drift spacing, depth and location of emplacement areas, and location of ventilation raises. The Final EIS describes a design for the repository with variations on the operating mode. The key parameters defining the flexible operating modes are waste package spacing, length of active ventilation, and waste package loading (principally the age of the fuel being emplaced). The range of variances in these parameters basically determine the extent of the repository design that will be utilized for emplacement of 70,000 metric tons of waste and fuel; the higher-temperature operating mode would require only the main central segment of the repository, several of the lower-temperature operating modes would use that segment and the western extension, while the “ultra” low-temperature operating mode would require use of the entire planned initial design.

2. In the Draft EIS, DOE evaluated a preliminary design based on the *Viability Assessment of a Repository at Yucca Mountain* (DIRS 101779-DOE 1998) that focused on the amount of spent nuclear fuel (and associated thermal output) that DOE would emplace per unit area of the repository (called areal mass loading). Areal mass loading was represented for analytical purposes in the Draft EIS by three thermal load scenarios: a high thermal load of 85 metric tons of heavy metal (MTHM) per acre, an intermediate thermal load of 60 MTHM per acre, and a low thermal load of 25 MTHM per acre. DOE selected these analytical scenarios to represent the range of foreseeable design features and operating modes, and to ensure that it considered the associated range of potential environmental impacts within the framework of a design the central feature of which was areal mass loading.

   Since DOE issued the Draft EIS, it has continued to evaluate design features and operating modes that would reduce uncertainties in or improve long-term repository performance, and improve operational safety and efficiency. The result of the design evolution process was the development of the flexible design that was evaluated in the Supplement to the Draft EIS and is evaluated in this Final EIS. This design focuses on controlling the temperature of the rock between the waste emplacement drifts (as opposed to areal mass

loading) by varying other parameters such as the heat output per unit length of the emplacement drift and the distances between waste packages. Within this design framework of controlling the temperature of the rock, DOE selected these lower- and higher-temperature operating modes to represent the range of foreseeable design features and operating modes, and to ensure that it considered the associated range of potential environmental impacts (DOE recognizes that many of the short-term impacts tended to increase over those discussed in the Draft EIS).

In this Final EIS, DOE varied design parameters to create scenarios to illustrate lower- and higher-temperature operating modes in such a way as to provide the range of potential environmental impacts. Furthermore, to not underestimate the environmental impacts that could result from implementing any of the lower- or higher-temperature operating modes, DOE has relied on conservative, yet realistic, assumptions when uncertainties remain.

3. In this Final EIS, DOE has updated and expanded the description of the flexible design and associated facilities, as well as performed a complete analysis to describe the range of potential environmental impacts that could occur under the Proposed Action. The tables in Section 2.4 of the Final EIS demonstrate the bounding nature of the flexible operating modes within the construct of a fixed design.

4. In the Supplement to the Draft EIS total worker years are used as a primary impact indicator for occupational health and safety impacts. As noted on page 3-1, "The Department used the ratio of primary impact indicators to specific impacts in the Draft EIS to determine the Supplement impact estimates." Therefore, in the analysis the base ratio of involved (including radiation workers) workers to noninvolved (including general employees) workers was the kept the same as for the Draft EIS. The exposure [dose] levels used were the same as described in Appendix F of the Draft EIS. The total dose to each of these worker populations was changed accordingly for the total length flexible design being considered as compared to the Draft EIS high thermal load scenario. The additional time needed for repository monitoring and maintenance was included in the Supplement estimates. A complete analysis of worker impacts under the flexible design operating modes is presented in Section 4.1.7 of the Final EIS. Section 4.1.7.5 shows that over the duration of the project construction, operation and monitoring, and closure phases the dose to the maximally exposed worker is about the same as shown for the thermal load scenarios in the Draft EIS.